Temperature Correction for GFO Wind Speed

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Introduction

One of the primary NGDR products from the GEOSAT Follow-On (GFO) Altimeter is wind speed. In the course of our analyses, it has been observed by the GFO Performance Assessment Team at Wallops Flight Facility that the GFO wind speed has a small dependency on Receiver Temperature. A temperature correction for the wind speed has been empirically derived, and is described below.

[Note: All the figures in this temperature-dependency report have been extracted from Lockwood et al, 2003, the yearly-updated GFO engineering performance assessment report produced by Wallops Flight Facility.]

Cause and Effect

The GFO wind speed calculation (Naval Oceanographic Office, 1999) on the NGDR is based on backscatter, Sigma0, employing a modified Chelton Wentz algorithm.

The GFO Sigma0 has a small Receiver Temperature dependency of approximately 0.04 dB per degree Celsius, with the Sigma0 rising with increasing temperature, as depicted in Figure 1 wherein the Sigma0 and Receiver Temperatures are both cycle-averaged. Sigma0 is plotted as dB in Figure 1, and the Receiver Temperature is in degrees Celsius.

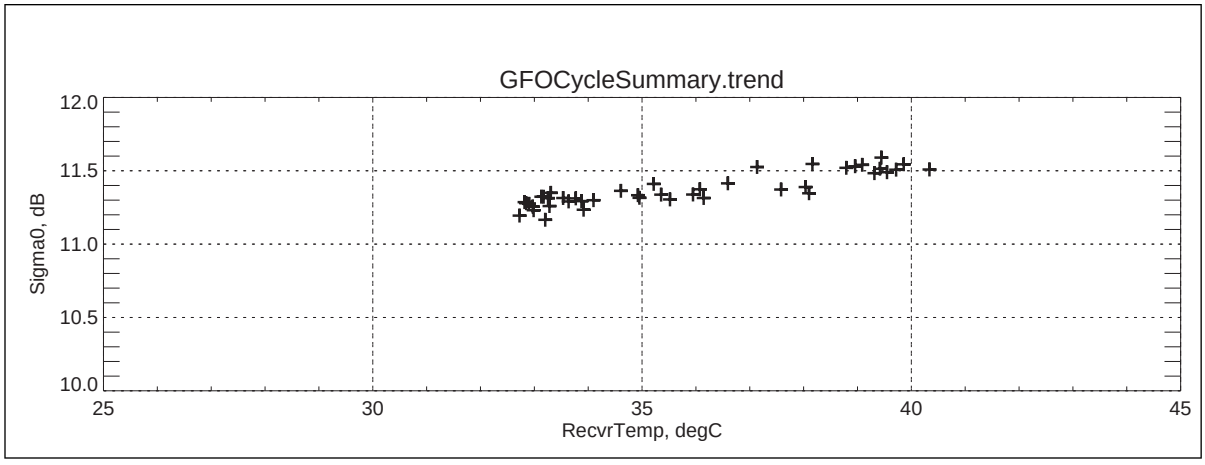

Figure 1 Cycle-Averages Sigma0 vs. Temperature

Upon using the modified Chelton Wentz algorithm, the temperature-dependence error in Sigma0 may be expected to propagate into a wind speed error.

In Figure 2, the cycle-averaged wind speed (in units of meters/second) is plotted against cycle number and, in Figure 3, the cycle-averaged receiver temperature (in degrees Celsius) is plotted against cycle number. A cursory examination of Figures 2 and 3 indicates that the GFO wind speed is inversely proportional to the Receiver Temperature. This observation is consistent with the Sigma0 increasing with increasing temperatures and vice-versa.

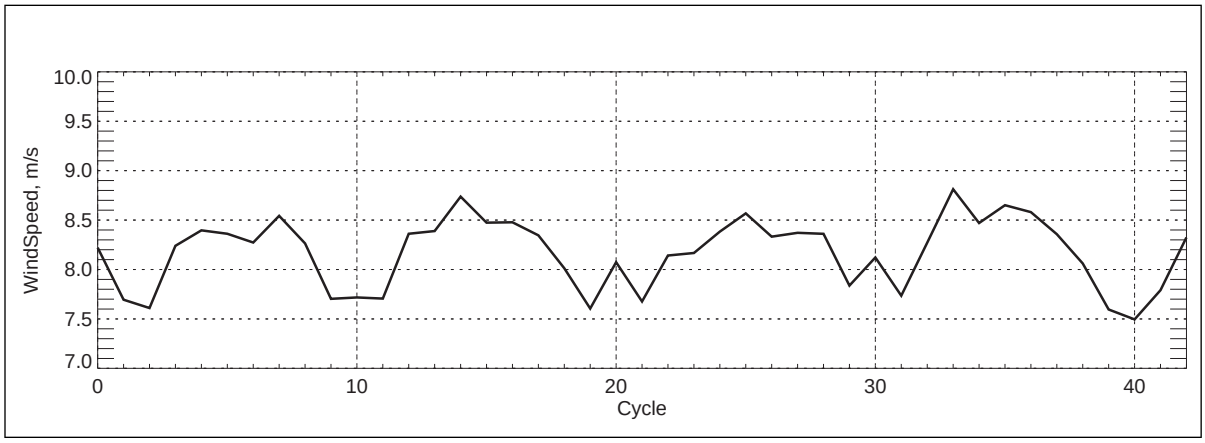

Figure 2 Cycle-Averages Windspeed in Meters Per Second

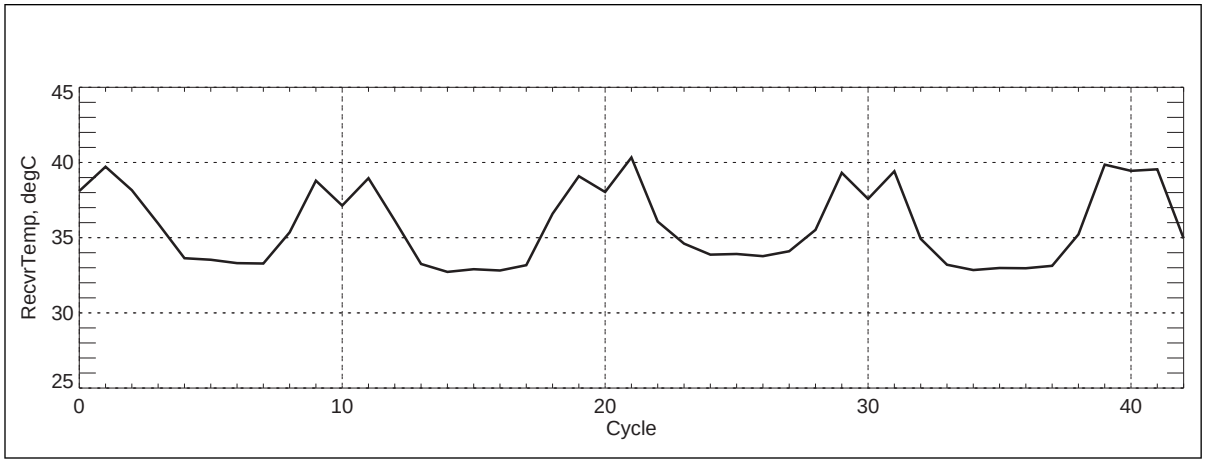

Figure 3 Cycle-Averages Receiver Temperature in Celsius Degrees

Wind Speed Correction for Temperature

Combining the data in Figures 2 and 3, a temperature correction for wind speed has been derived:

$$W_C = W_O + (T_R - 35.77) * 0.117$$

where W_C = the GFO wind speed in meters / second corrected for temperature effects

W_O = the GFO windspeed in meters / second from the NGDR

T_R = the GFO Receiver Temperature in degrees Celsius from the NGDR

In the above temperature correction equation, the value of 35.77 is the average Receiver Temperature for all the 43 cycles of GFO data since launch that have been assessed in Lockwood et al (2003). The scale factor of 0.117 is in units of m/sec per degree.

Results

After applying the derived temperature correction, the revised cycle-averaged wind speed is plotted versus the cycle number in Figure 4.

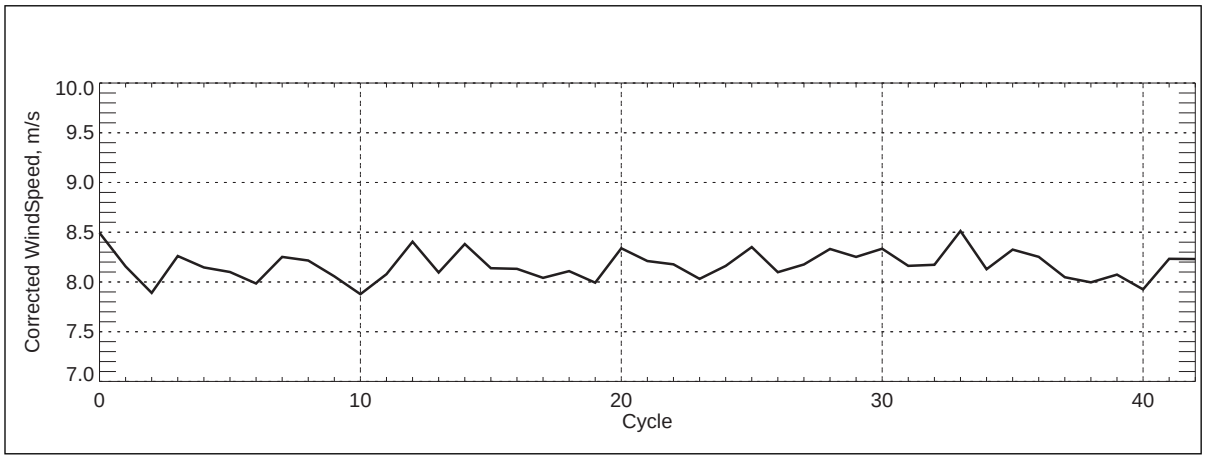

Figure 4 Cycle-Averages Corrected Windspeed in Meters Per Second

A comparison of Figure 2 (prior to temperature correction) and Figure 4 (subsequent to temperature correction) shows that the variation of cycle-averaged wind speeds is reduced, after temperature correction, from a span of 7.5-8.8 meters/second to a smaller span of 7.9-8.5 meters/second. The remaining small variations in the GFO windspeed are within what is expected for cycle-to-cycle and seasonal changes that we have monitored in TOPEX altimeter performance.

References

Lockwood, D.W., D. W. Hancock III, G.S. Hayne and R. L. Brooks, 2003,
GFO Altimeter Engineering Assessment Report — Update: The First 43 Cycles Since Acceptance.

Naval Oceanographic Office, 1999, Navy-IGDR Users Handbook.